

ANSWERS Crystal Ball (Year 11): Rate of reaction and particle theory

1) a) Decrease concentration of a reactant and Decrease temperature.

b) Experiment 2 and 1

Concentration of a reactant has decreased, which decreased the rate of reaction.

This means there are fewer reactant particles per unit volume so the collision rate decreases.

Experiment 3 and 1

Temperature is increased, so the rate of reaction increases.

This means:

The particles have more average kinetic energy and are moving faster. There will be an increase in the frequency of collisions between particles.

Particles also collide more effectively as the particles have more energy.

2) a) i) The time taken would be longer (ie, slower reaction rate).

ii) The time taken would be longer (ie, slower reaction rate).

b) For a reaction to occur particles must collide and these collisions must be effective. For a collision to be effective particles must have energy greater than the activation energy (this is the minimum energy that a particle needs to react when it collides).

When the concentration is decreased there is a decreased frequency of collisions between particles so fewer particles react. This means that the rate of reaction is decreased.

When the temperature is decreased the kinetic energy and hence the speed of reacting particles decreases. This means that particles collide less frequently. It also means that the particles collide with less energy (and less effective collision) as fewer particles have energy greater than the activation energy.

In both instances (ie diluted solution, lower temperature) the solution would take longer to go cloudy as the collisions between the hydrochloric acid and the sodium thiosulfate would occur less frequently and/or the collisions would be less effective.

3) i) A: It has higher concentration.

It has more particles in a given volume. It has more frequent collisions. It has a higher rate of reaction.

ii) Granules have greater surface area. Thus more Zn atoms are exposed. Thus more frequent collisions occur.

iii) The change causes a lower rate of reaction. It lowers kinetic energy. It causes less frequent collisions. Thus fewer collisions are successful.

4)

	Factor	Effect
Change One	concentration	decrease
Change Two	temperature	increase
Change Three	surface area	decrease

The concentration of hydrochloric acid has decreased, so there are fewer particles per unit volume of acid to react at any one time. Lower concentration means that there is a decrease in the frequency of collisions, so the frequency of effective collisions decreases. Hence the reaction occurs more slowly.

5) a) Rate of reaction can be increased by

- increasing the temperature (heat the reaction)
- increasing the surface area of the calcium carbonate (use powdered calcium carbonate)
- increasing the concentration of hydrochloric acid. (not reactants).

b) Line A – Beaker 3

Line B – Beakers 1 and 2

Beakers 1 and 2 have the same concentration of HCl and Beaker 3 has a lower concentration of HCl.

Line B corresponds to beakers 1 and 2 because it is steeper showing a faster rate of reaction. In Beakers 1 and 2, there are more reactant particles per unit volume compared to Beaker 3, so the concentration is greater. As the concentration of reactants is increased, the collision rate of reactant particles increases, so there are more successful / effective collisions and the reaction rate is increased. Hence a steeper line on the graph

Line A corresponds to beaker 3 because it is less steep and shows a slower rate of reaction. In beaker 3 there are fewer reactant particles per unit volume compared to beakers 1 and 2, so the concentration is lower. As the concentration of the reactants is decreased, the collision rate of the reactant particles decreases, so there are fewer successful / effective collisions and the rate of the reaction is decreased.

c) i) States that as temperature increases the rate of reaction increases / time taken for the solution to decolourise decreases.

ii) This is because as temperature increases, the molecules have more kinetic energy / higher energy and moving faster. There will be an increase in the frequency of collisions between particles. Particles also collide more effectively when they actually do collide. There are more effective / successful collisions because more particles have enough kinetic energy to overcome the activation energy for the reaction. Leading to an increased rate of reaction

6) a) Solution has been diluted so fewer acid particles in same volume; collision rate decreases so number of effective / successful collisions decreases. Hence, rate decreases.

b) Carry out two experiments, one with Cu and the other without. Both experiments use same mass of zinc and same conc. and volume of acid.

Time how long each reaction takes, eg bubbles formed in time period, volume of gas in time period, length of time for reaction to complete.

Use a weighed mass of Cu and reweigh at the end to determine whether it has been used in the reaction.

An increased reaction rate with Cu not used up will mean it is a catalyst for the reaction.

7) Surface area:

Greater surface area: greater rate

Greater surface area hence an increase in the frequency of collisions.

8) Decrease / less time or similar / faster rate

An increase in temperature means the particles have more kinetic energy. An increased number of collisions of particles, in a given time, will now reach the activation energy required for the reaction. Also there will be more collisions /

time. Therefore, the frequency of successful collisions will increase. Thus the reaction rate is increased so the time required for reaction is decreased.